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THE THEORY OF RADIO-WAVE PROPAGATION IN A NONHOMOGENEOUS ATMOSPHERE FOR A SLIGHTLY RAISED SOURCE

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/A Digest/

The theory of radio-wave propagation in an atmosphere whose dielectric constant depends upon height has already been elaborated for the case where the source is a vertical electric dipole placed on the earth's surface. On the other hand, the case of a raised source (horizontal and vertical, electrical and magnetic dipoles) has been considered under the assumption of a homogeneous atmosphere. This article studies the "combined" case: a raised dipole and nonhomogeneous atmosphere.

The formulas derived in the first case above, for the general case where the index of refraction behaves arbitrarily, were developed in great detail on the assumption of normal refraction, where radio-wave propagation possesses qualitatively the same nature as in a homogeneous atmosphere. The case of superrefraction where the lower layer of the atmosphere acquires the character of a wave guide is of independent interest and deserves special consideration. This article discusses this case in detail. For its quantitative characteristic, it is very useful to point out its similarity to the nonstationary problem of quantum mechanics on the spreading of wave packets in a given field of force; this similarity has remained unnoticed up to now.

The problem of radio-wave propagation under conditions where the atmosphere plays the role of a wave guide was taken up also by P. Ye. Krasnushkin, who applied the method of normal waves to plano-laminar and spherico-laminar media (see his brochure, "Metod Normal'nykh Voln v Primenenii k Probleme Dal'nikh Radiosvyazey," 1947, Moscow State University). Krasnushkin's interesting research, however, has mainly a qualitative character and leaves unexplained a series of essential mathematical problems, particularly the problems

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of the spectrum ("range") of complex eigenvalues of the "normal waves" and the problems of the limiting conditions for the corresponding "normal functions."

Section 1 of the article describes the basic equations and limiting conditions of the problem.

Section 2 considers the approximate forms of the equations (Leontovich's parabolic equation) with suitable limiting conditions and with the conditions that determine the characteristic ("singularity").

Section 3 draws the similarity between this problem as formulated and the nonstationary problem of quantum mechanics.

Section 4 makes the transition to dimensionless quantities.

Section 5 studies the properties of the partial solutions of the differential equations.

Section 6 constructs from the previous differential equations the general solution in the form of a contour integral and in the form of a series.

Section 7 then considers an example where the curve of the given index of refraction is assumed to be composed of two rectilinear portions.

Section 8 gives the approximate formulas that are similar to the semiclassical formulas of quantum mechanics for the determination of the coefficients of damping and the "altitude factors." Problems encountered in the methodology or procedure of numerical calculations are not treated in the article.

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